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LIVERMORE SCIENTIST CONTRIBUTES TO STUDY OF LINK BETWEEN AEROSOLS AND CLOUD FORMATION

LIVERMORE, CA, May 6, 2004 — A team of scientists, including Lawrence Livermore computer scientist David Stevens, led by researchers from NASA Ames Research Center, have discovered a link between tropical anvil cirrus and mid-tropospheric aerosols. This link has important ramifications for the understanding of climate change. The team, with additional collaborators from the National Center for Atmospheric Research, University of North Dakota, Hampton University, Universidad Nacional Autonoma de Mexico, Stratton Park Engineering Company Inc., University of Denver, California Institute of Technology and Center for Remotely-Piloted Aircraft Studies, is reporting its most recent findings in the April 30 edition of the journal *Science*.

The study focused on tropical anvil cirrus clouds, an important but poorly understood element of the Earth's climate system. These clouds have been found to respond strongly to increasing sea surface temperatures and, consequently, to play a major role in global climate change. By comparing measurements of aerosols and cloud particles from the NASA CRYSTAL-FACE field experiment to detailed cloud simulations, the researchers found that most anvil ice crystals form on mid-tropospheric (6–10 kilometers above the Earth's surface) aerosols. Scientists previously assumed the aerosols necessary for cloud formation originated closer to the Earth's surface.

The atmosphere has multiple layers, the lowest of which is the turbulent atmospheric boundary layer that is directly influenced by surface processes and extends from the earth's surface to often 2 kilometers or more in the tropics. The atmospheric boundary layer is followed by the troposphere, which varies in height 8–10 kilometers and contains most of the atmosphere's mass. The troposphere is then capped by the strongly stratified stratosphere which extends 10–50 kilometers above the surface. The tropopause is the transition zone between the troposphere and the stratosphere and is approximately the altitude of commercial aircraft flight.

The computational model used in this study had to include aerosols above 6 kilometers in order to accurately simulate the large number of cloud particles that were observed during the field experiment (See Figure 1). Previous studies often only considered aerosols from the atmospheric boundary layer and were unable to predict the number of cloud particles observed. The results also show that polluted mid-tropospheric aerosol concentrations may affect cirrus cloud radiative properties, evolution, and lifetime.

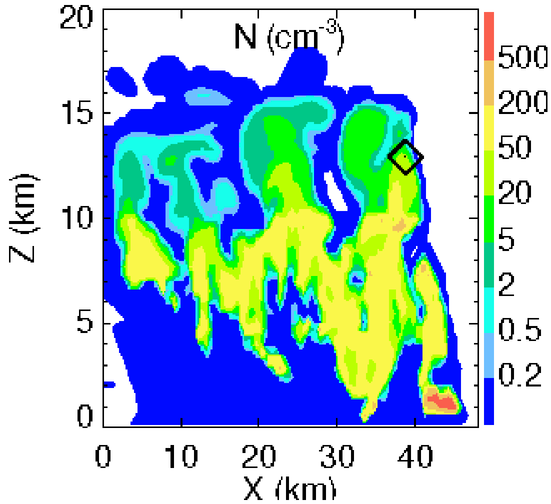

Figure 1. Cross-section of simulated cloud particle number concentration. Simulated particle size distributions closely match measured values when all aerosols above 6 kilometers are included.

The computational model, DHARMA, used in this study was made possible by a long collaboration between David Stevens of the Lab's Center for Applied Scientific Computing and the NASA AMES researchers. In particular, high performance parallel computing was essential to the success of this investigation. DHARMA has been extensively used with Livermore's ASCI WHITE to study atmospheric convection. The cross-section of condensed cloud water shown in Figure 2 is from the largest atmospheric large eddy simulation performed to date involving more than 2 billion computational zones. These simulations were able to capture scale interactions in the study of trade cumulus convection that had never been previously simulated.

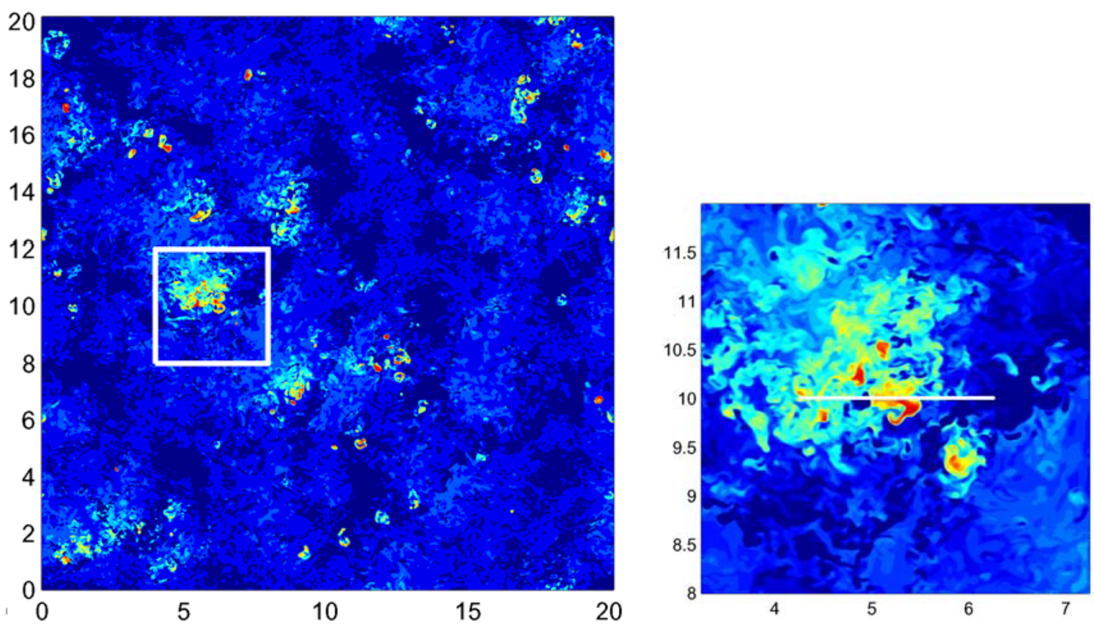

Figure 2. (Left) Horizontal cross-section of the condensed water field of a DHARMA simulation of trade cumulus convection. The computational domain involved 2016 and 600 zones in the horizontal and vertical directions, respectively. Blue represents clear air, and red represents air with 1.6 g condensate per kg dry air. (Right) Enhanced image of the white rectangle showing the fine-scale structure that was simulated. This simulation was published in the *Journal of the Atmospheric Sciences*.